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Impact of Teaching English Triple Onset and Coda Clusters on Yemeni EFL Undergraduates: A Phonological Study

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Abstract:

The intention of this paper is to explore the impact of the explicit instruction of English phonotactic constraints on the achievement of Yemeni EFL undergraduate learners in triple

onset and triple coda clusters. 76 subjects from Thamar University in Yemen comprised the Yemeni non-native English groups; equally divided into control and experimental groups. 5 native speakers of English participated as a native control group. All groups were pre-tested using *Triple Onset* and *Triple Coda Tasks* developed by the researcher. Then experimental group was given a treatment consisting of relevant English triple onset and coda clusters. That was followed by a post-test for the Yemeni groups. *The pre-test* results revealed that Yemeni EFL groups did not perform well. The reason could be that clusters are not taught explicitly to the learners in the previous stages and/or the effect of the negative transfer of L1 rules, Arabic, into L2, English. *The post-test* results showed significant achievement in triple onsets and codas by the experimental group and this improvement is due to the effect of the training programme conducted on this group.

Key words: triple onsets, triple codas, clusters, phonotactic constraints, Yemeni EFL learners

1. Introduction

A consonant cluster, either word-initially, medially or finally, is a group of consonant phonemes that appear adjacently in a syllable without a vowel between them. In view of the information available in the published literature on phonology, linguists generally agree that consonant clusters are defined as the two or more consonants that come together either in the beginning or at the end of a syllable (Roach, 2014: 68; Gut, 2009b: 77). English language allows a combination of two and three consonant clusters in the onset position of the syllable and two, three, and four consonant clusters in the coda position. For a great number of Arab learners, including Yemenis, they lack sufficient knowledge about clusters of English and in many instances they tend to pronounce them by inserting a vowel between the consonant clusters.

Triple onset clusters are three consecutive consonant phonemes that occur before the nucleus (i.e. vowel) at the beginning of a word such as [str-, stj-, spr-, spl-, skr-, scl-, but not srt-, sjt-, rps-, or srk-] as exemplified in the initial of the words '*string'*, '*student'*, '*spread'*, '*split'*, *'scratch'* and '*sclerosis'*, respectively. On the other hand, triple coda clusters are three consecutive consonant phonemes that occur after the nucleus at the end of a word such as [-rst, -kst, -nst, -mpt, -lpt, but not -str or -skw] as in '*burst'*, '*text'*, '*against'*, '*attempt'*, and '*sculpt'*, respectively. From the above examples, it can be clearly noticed that English allows a combination of three consonant clusters word-initially and finally. However, the clusters that are permitted to appear in the onset position are not permitted to appear in the coda position and vice versa.

In English, the phoneme /ŋ/ neither occupy the onset position of a syllable nor occur before a vowel. Similarly, the phonemes /h/, /w/ and /j/ can never occupy the coda position of a syllable or occur after a vowel. This is the case of single phonemes. Restrictions also apply in case of having double and triple consonant clusters. For example, clusters such as /pr-/, /br-/ and /spr-/ are completely allowed to occur syllable or word-initially as in '*print'*, '*bring'* and '*sprint'*, respectively, but they are completely illegal in syllable or word-finally. On the contrary, clusters such as /-mp/ and /-mpt/ are permitted to occur syllable or word-finally as in '*camp'* and '*attempt'*, respectively, but they are not permitted to occur syllable or word- initially. A language such as Modern Standard Arabic (MSA hereafter), the language of the researcher and subjects of the current study, does not admit any consonant clusters in syllable or word-initially and the maximum clusters that can occur in the coda position are of two.

The triple onsets of English tend to have a simple formula when compared to the three-member consonant coda clusters. They are composed of the phoneme /s/ as C1, the voiceless stops (/p, t, or k/) as C2 and the approximants (/l, r, w, or j/) as C3. According to (Yavaş

2011: 142), the combinations of this phonotactic constraint rule can give us 12 logical possibilities, but only 7 of these occur as illustrated in the words '*splash'*, *'spring'*, *'spew'*, *'street'*, *'screen'*, *'square'* and *'skew'*. This research argues that two more possibilities can be added to have a triple onset clusters and these are: 'stj-' and 'scl-' as in the words '*stupid'* and '*sclerosis'*, respectively.

When examining the non-suffixed combinations of triple codas, it can be noticed that a large number of instances are composed of a *liquid* or a *nasal* as C_1. As for C_2 and C_3 they are *voiceless obstruents*. For example, nasals [m, n and ŋ] can be followed by two voiceless obstruents as in /-mpt/, /-nst/, /-ŋkt/ as exemplified in the final of the words '*attempt'*, '*against'*, and '*distinct'*, respectively. Similarly, the liquids [l and r] can by followed by two voiceless obstruents as in /-lpt/, /-lts/, /-lst/, /-rpt/, /-rps/, /-rst/, and /-rld/ as in the final of the words '*sculpt'*, '*waltz'*, '*whilst'*, '*excerpt'*, '*corpse'*, '*first'*, and '*world'*, respectively. In addition to the above combinations, one more combination can be constructed in which C_1 is a stop, C_2 is a fricative and C_3 is another stop as in /-dst/ and /-kst/ as in the final of the words '*midst'*, and '*text'*.

The possibilities of formulating triple codas can be maximized considerably by the use of suffixation. For instance, the suffixes [d and t] can be added as C_3 to indicate the past tense, [s and z] to indicate the third person single, plurality, or possession, and [θ] to formulate an ordinal number from a cardinal number or change an adjective into a noun. This can be exemplified in the words '*earned'* and '*helped'* (in which the suffixes [d and t] are past markers), '*lists'* and '*bulbs'* (in which the suffixes [s and z] are markers of the third person single and plurality) and '*sixth'* and '*strength'* (in which the suffix [θ] converts the cardinal number into an ordinal one and an adjective into a noun). From the above explanation, it can be noticed that languages do not use all the combinations possible in their phoneme inventories.

The problem of phonotactic constraint rules i.e. the permissible and non-permissible syllable-initial and syllable-final cluster sequences, remains a heavy burden to Yemeni students even those specializing in English at university level. The fact is that the topic of phonotactics and its constraints are not covered explicitly and comprehensively in the English syllabus of Thamar University in general and in the Phonology course in particular. The researcher believes that teaching the constraints explicitly and comprehensively would improve the learner's motivations and therefore make learning better and faster.

2. Previous Studies

Robert Stockwell was the first to introduce the term phonotactics to the linguistic literature in the mid-1950's (Menn, 2004, 55). In fact, each language has its own restrictions regarding the distribution of their phones and their combinatory possibilities and this area is covered by phonotactics that can be considered a branch of phonology (Syamala, 2010: 82). According to Knight (2013: 106), phonotactics refers to which sequences of sounds are allowed within a syllable in any particular language. The restrictions on the types of sounds that are allowed to occur next to each other or in particular positions in words are referred to as phonotactic constraints (Zsiga, 2013: 222-23). Zsiga indicates that in the literature, the sequence of clusters ruled out by phonotactic constraints differ from language to another. English, for instance, does not allow nasals followed by stops like /mb/ in the initial position. Conversely, Swahili allows for this combination as in [mba]. Greek is the opposite of Swahili in which the combination of stop followed by nasal as in [pneu] is a fine word, but the reverse is not possible as in *[mba]. Senufo (West Africa), Arabic and other languages do not allow consonant clusters on the onset position at all. Therefore, having knowledge on the phonotactic constraints in different languages and accounting for how they may differ or be similar across linguistically, is one of the important tasks of the phonological theory.

Na'ama (2011: 145- 65) carried out a study on Yemeni students at Al-Hodeidah University and aimed to critically analyse the errors Yemeni students make in the English consonant clusters' system especially in pronunciation. A sample of 45 undergraduate students were selected from three different level viz. level I, II, and III to participate in the study. Na'ama argues that Yemeni students tend to follow the strategy of inserting a vowel segment within an existing string or cluster reduction. They pronounce the English words that have two clusters or more, either word-initially or finally as *(*/spɪred/, /spɪlended/, /pɪleɪ/, /nekɪst/),* etc. for the words 'spread', 'splendid', 'play', and 'next', respectively.

The conclusion reached by Na'ama was that the participants made a variety of errors in pronouncing English consonant clusters due to several factors. He relates the first factor to the effect of mother tongue, Arabic, because of negative transfer in a way that there are major differences between Arabic and English consonant clusters. The second factor is the insufficient practice of the listening skills by the Yemeni university students i.e. Yemeni learners do not usually utilise the various kinds of audio and video aids to improve the standard of their pronunciation. The third factor is the inadequate pronunciation of the university instructors which makes university students unaware of the proper pronunciation of English clusters. All these factors lead Yemeni university students to break up the consonant clusters by following the strategies of epenthesis and cluster reduction. As a remedy, Na'ama stressed on implementing appropriate teaching methods and techniques. In fact, one objective of the present study is to develop an approach for teaching the clusters to Yemeni EFL learners at the university level (see section 4.4 below).

Collins and Mees (2013: 215) has ranked three types of errors and difficulties faced by different speakers of different communities when it comes to learning English. One type of errors that is widespread and committed by a large number of learners is what they call 'Errors leading to potential breakdown of intelligibility'. Under this category comes the error

of consonant clusters mainly made by Arab and Spanish learners of English. Like Arabic, the syllable structure of Spanish is less complex than that of English. In Spanish, the initial consonant /s/ cannot cluster with other consonants in the onset position. Similarly, the possibilities in coda position are far fewer than that of English. Only final /n, l, r, s, d and θ / occur with any frequency. Collins and Mees stress that final consonants and consonant clusters in general are a major problem area for Spanish speakers. This means that '*span*' will be produced by learners as */espan/ in which the word of one syllable becomes of two syllables because of adding the epenthetic vowel /e/ before the onset clusters.

In a study carried out by Bin-Hady (2016: 141), he confirms that Arab learners of EFL do insert the front short vowel /ɪ/ syllable-initially and finally of English words. For instance, learners produce */sɪbli:n/ 'spleen', */sɪtreɪn/ 'strain', */sɪkræp/ 'scrap', etc. by breaking the clusters and adding the vowel sound /ɪ/ after the first consonant in the onset position. It can be also noticed that learners convert the English voiceless bilabial stop into voiced bilabial stop. As for the coda position, Bin-Hady provides the following examples, */stʊbɪd/ 'stopped', */dɪvɪlʊbɪd/ 'developed', */lɑ:fɪd/ 'laughed', */ɑ:skɪd/ 'asked', */wɔ:kɪd/ 'walked', */gru:bɪz/ 'groups'.

From the previous studies, it can be observed that triple clusters are problematic to Arab learners of English in which they are insensitive to them and in most cases they tend to insert an extra vowel (epenthesis /ɪ/) between the clusters in the onset or coda positions of English words. The result is a word of two syllables instead of one as in */sɪb●li:n/ 'spleen' and */te●kɪst/ 'text'. The reasons for committing the above errors could be related to the fact that the topic of English phonotactic constraints is not covered in the syllabus to be taught explicitly and comprehensively to the Arab learners. Additionally, Arabic does not allow for any clustering in the initial position of a syllable or word. Therefore, Arab learners may apply the phonotactic rules of their native language in producing English syllables or words, as is

the case of inserting the vowel /ɪ/ to the onset and coda clusters of English. Therefore, the intention of this study was to evaluate the impact of the explicit and comprehensive teaching of phonotactic constraints of triple onsets and codas on the mastery to learn about these constraints by Yemeni EFL learners.

3. Objective, Hypotheses and Questions of the Study

The objective of the present study was to investigate the impact of the explicit teaching of the triple onset and triple coda clusters of English on the gain of the Yemen learners of English at the university level. Therefore, the hypotheses below are posed to be examined:

Hypothesis 1: The achievement score of native control group on triple onset clusters is significantly higher than that of Yemeni experimental and control groups in the *pre-test*.

Hypothesis 2: The achievement score of native control group on triple coda clusters is significantly higher than that of Yemeni experimental and control groups' post-*test*.

Hypothesis 3: There is no significant difference in the achievement of experimental group of Yemeni EFL undergraduate learners taught the *triple onset clusters of English consonant phonemes* over the control group.

Hypothesis 4: There is no significant difference in the achievement of experimental group of Yemeni EFL undergraduate learners taught the *triple coda clusters of English consonant phonemes* over the control group.

To achieve the objective of the current study, the following questions need to be answered:

Question 1: Are Yemeni EFL undergraduate learners sensitive to *triple onset clusters* of English consonant sounds?

Will the answer to the above question differ from control to experimental group and from pre-test to post-test within and across groups?

Question 2: Are Yemeni EFL undergraduate learners sensitive to triple coda clusters of English consonant sounds?

Will the answer to the above question differ from control to experimental group and from pre-test to post-test within and across groups?

4. Methodology

Below is a brief account for the methodology followed in the present study.

4.1 Participants

The participants in the present study were Yemeni EFL university students. They were selected randomly from the English Language Department in the Faculty of Education at Thamar University. The sample consisted of 76 students and comprised two groups, in which 38 subjects were assigned in the control group and 38 subjects in the experimental group. In addition, there were 5 native speakers of English who comprised the native control group. The Yemeni EFL subjects possessed the following characteristics:

- 20–26 years old; males 50% and females 50%.
- Level three of four years university study.
- Six years EFL instruction prior to university.
- Arabic is their native language
- None has spent time abroad in an English-speaking environment

4.2 Method

To examine the above hypotheses and answer the two raised questions, a *questionnaire* with two tasks on triple onsets and triple codas was adopted and administered to the selected sample. Each task in the questionnaire contained twenty items (see appendix A). The researcher developed the items of this instrument, and then, they were piloted by 4 Yemeni

doctorate and masters students (specialised in linguistics at University of Kerala, India) and two Native Americans doing their postgraduate studies at Hyderabad Central University. The piloting yielded apt and remedial comments for the production of the final questionnaire.

The design of this study followed a pre-test-treatment–post-test design. All the three groups took two tasks as a test in the form of close-ended questionnaire namely, Triple Onset Clusters Task and Triple Coda Clusters Task in the pre-test. The two tasks aimed to test Yemeni EFL learners' knowledge of phonotactic constraints relevant to English triple onset and coda clusters. As for the post-test, only the Yemeni groups were post-tested with the same tasks, during which the experimental group was separated from the control group and received training on the phonotactic constraints of triple onset and coda clusters. The two tasks required subjects to visually classify the presented items in the questionnaire into English possible and impossible triple onsets and triple codas. The researcher administered the questionnaire and gave instructions to the participants on the two tasks to avoid ambiguity and misunderstanding.

The native language of the subjects, Arabic, was taken into consideration during the treatment delivered to the experimental group. The phonotactic rules of onset and coda clusters of Arabic and English were discussed in order to distinguish and prevent the transfer from the native language of the subjects into English. The researcher predicted that Yemeni learners would not show sensitivity to the possible English triple onset and triple coda clusters. However, all this information remains hypothetical and therefore the hypotheses stated above (see section 3) were taken regarding Yemeni subjects' performance in the two tasks.

4.3 Pre-test

As mentioned earlier, there were 76 Yemeni participants comprised the non-natives of English groups and 5 English participants that comprised native control group. Each group, non-native and native, was tested with the same question items. The pre-test aimed at measuring the existing phonotactic knowledge of triple onset and triple coda clusters of the non-native subjects before conducting the treatment. The test consisted of two tasks with a total number of 40 test items. Each task contained 20 question items (see appendix A) that require subjects to tick (√) next to the correct option and incorrect options to be left blank. The two Yemeni groups were pre-tested simultaneously with the same question items and in the same location. As for the Native group participants, each subject was tested individually as they were residing in different parts in Kerala State, India. When pre-testing the three groups and to ensure maximum understanding of the tasks, the researcher thoroughly explained the requirements of the tasks to the subjects.

4.4 Treatment

Recall that only the experimental group participants were subjected to a treatment (i.e. special training programme) on triple onset and triple coda clusters. However, both groups attended the course of Phonology all through the semester in the year 2016-2017. The treatment package was conducted in two stages:

The *first stage* included a detailed explanation on the phonotactic constraints of English triple onsets. Students were made aware that the phonotactic constraints of triple onsets differ from language to another. For instance, English permits a combination of three consonant phonemes to appear in the initial position of a syllable or word as in the initial of the words '*string'*, '*script'* and '*splash'*, however, a language like Arabic does not admit any clustering on the onset position. The permission for English to have three clusters, as exemplified

above, is highly restricted (i.e. no three consonant clusters can appear freely). All the constraints related to the three-member consonant onset clusters were explained to the students followed by an extensive in-class practice by the students and with the help of the researcher (the teacher). At the end, a formula of the triple onset clusters was proposed as shown in Table 1 below:

Table 1: English Triple Onset Clusters

C1	C2	C3	
S	p	r	spring
		l	splash
		j	spew
		w*	
S	t	r	string
		l*	
		j	student
		w*	
S	k	r	screen
		l	sclerosis
		j	skew
		w	squeeze

The *second stage* was concerned with the constraints of three-member consonant coda clusters which are more difficult to master and also do not lend themselves to the rather simple formula when compared to the three-member consonant onset clusters. One important

fact was stressed out during the training programme that the language of the participants, Arabic, does not admit triple consonants in the coda position, but English does. Therefore, participants were made aware to make distinction between the constraints of their native language and the target language, English, and refrain from applying the transfer strategy. In this stage, another plausible remark was pointed out that the likelihood of formulating triple codas can be maximized extensively by the use of the suffixation process as in adding the phonemes [s, z, t, d, θ], to the end of a syllable or word as in /æsks/ '*asks'*, /endz/ '*ends'*, /helpt/ '*helped'*, /fɪlmd/ '*filmed'*, and /sɪksθ/ '*sixth'*.

According to (Yavaş 2011: 144), the formula of the triple codas of English is not as simple as the formula given for triple onsets, rather they tend to be more complicated. The following combinations are found in *non-suffixed forms* as Table 2 shows:

Table 2: English Triple Coda Clusters in Non-Suffixed Forms

	C1	C2	C3	Examples
1	stop	fricative	stop	/dst/midst, /kst/next
2	nasal	stop	stop	/mpt/exempt, /ŋkt/ instinct
	nasal	stop	fricative	/mps/ mumps, /ŋks/ jinx
	nasal	fricative	stop	/nst/ against, /ŋst/ amongst
3	lateral	stop	stop	/lpt/ sculpt
	lateral	stop	fricative	/lts/ waltz
	lateral	fricative	stop	/lst/ whilst
4	trill	stop	stop	/rkt/ infarct, /rpt/ excerpt
	trill	stop	fricative	/rps/ corpse, /rts/ quartz
	trill	fricative	stop	/rst/ first

trill	lateral	stop	/rld/ world
trill	lateral	fricative	/lrz/ Charles

It can be clearly noted from the above table that with the exception of the first row that forms the triple codas by having three obstruents (stop, fricative, and stop), nearly all the other possibilities contain a liquid or a nasal followed by two voiceless obstruents. The above two tables and explanations are suggested to be adopted as an approach in teaching the triple clusters to Yemeni EFL learners at the university level as they nearly sum up and explain in brief all the possibilities of having triple onsets and coda clusters of English.

4.5 Post-test

After the completion of the pre-test, the treatment period started and ceased after 2 weeks in which two sessions were delivered (45 minutes per week) and that was followed by post-testing the two Yemeni groups. The same tasks and procedures used in the pre-test were applied in the post-test. The only difference was that native speaker group was not post-tested. The data obtained from the questionnaire were summarized and tabulated and then analysed statistically.

5. Results and Discussion

The present study is quantitative in nature and data have been organized, analysed and interpreted in a way in which the statistical techniques can help measure the degree of change that took place in the experimental group after they were subjected to the experimental package (treatment). The analysis of the data of the current study was conducted with the help of SPSS version 23 and Excel for Windows. Descriptive statistics such as mean, standard deviation and percentage and inferential statistics such as two-independent t-test were employed.

5.1 Pre-test Results

The first procedure employed in the analysis of the pre-test results aimed at exploring if there was any significant difference in the mean scores between the Yemeni non-native English groups in the 40 different items (see appendix A). Two-independent t-test was adopted to compare the mean scores of the two Yemeni groups. Table 1 below illustrates the mean scores of Yemeni experimental and control groups in the pre-test.

Table (1): Mean Score of Yemeni Experimental and Control Groups

Task	Yemeni Experimental		Yemeni Control			
	Mean	SD	Mean	SD	*t-test*	*Sig.*
Triple Onsets	3.21	2.26	3.42	2.24	*0.408*	*0.684*
Triple Codas	2.29	1.77	1.82	2.29	*1.010*	*0.316*

The results of the t-test in the above table indicate that the mean marks of Yemeni experimental and control groups are statistically same in both tasks as the significance level of the t-test is greater than 0.05. The results show that there is no significant difference in the achievement of Yemeni experimental and control groups. Therefore, the results of the two Yemeni groups in the pre-test of the *Two Tasks* indicate that they have a significantly same level of performance.

Table 2 below shows the mean scores of Yemeni experimental group's pre-test and native control group.

Table (2): Mean Scores of Yemeni Experimental Group and Native Control Group

Task	Yemeni Experimental		Native Control			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*

Triple Onsets	3.21	2.26	5.80	1.64	*2.470*	*0.018*
Triple Codas	2.29	1.77	2.80	2.59	*0.575*	*0.568*

With regard to the *triple onsets'* results, the t-test in the table above shows that the mean scores of Yemeni experimental group and native control group are significantly different as the significance level is less than 0.05. From the table, it is seen that the mean score of native control group is significantly higher than that of Yemeni experimental group. As for the *triple codas'* results, the t-test indicates that the mean scores of Yemeni experimental group and native control group are statistically same as the significance level is greater than 0.05. From the table, it is evident that the achievement of native control group in the triple codas is significantly same as that of Yemeni experimental group but higher in the triple onsets.

Table 3 presents the mean scores of Yemeni control group's pre-test and native control group.

Table (3): Mean Scores of Yemeni Control Group and Native Control Group

Task	Yemeni Control		Native Control			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*
Triple Onsets	3.42	2.24	5.80	1.64	*2.287*	*0.027*
Triple Codas	1.82	2.29	2.80	2.59	*0.892*	*0.378*

From the table, the result of t-test of *triple onsets* shows that the mean scores of Yemeni control group and native control group are significantly different as the significance level is less than 0.05. It is evident from the result that the achievement of native control group is significantly higher than that of Yemeni control group. However, the result of t-test of the

triple codas indicates that the mean scores of Yemeni control group and native control group are statistically same as the significance level is greater than 0.05.

5.2 Post-test Results

This part reports on the results drawn from the test conducted after the training programme, treatment, in which only the experimental group received the treatment package. The first procedure adopted in analysing the post-test results of the *Two Tasks* aimed at finding out if there was any significant difference between pre-test and post-test results of Yemeni control group. The mean scores of pre-test and post-test of this group are compared in Table 4 by the use of two-independent t-test.

Table (4): Mean Scores of Yemeni Control Pre-test with Post-test Results

Task	Pre-test		Post-test			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*
Triple Onsets	3.42	2.24	3.47	2.92	0.103	*0.919*
Triple Codas	1.82	2.29	3.03	2.43	2.241	*0.031*

The t-test of the *triple onsets* in the above table shows that there is no significant difference in the pre-test and post-test of Yemeni control group as the significance level is greater than 0.05. From the result, it can be inferred that Yemeni control group has no significant improvement in the achievement of post-test. On the other hand, the t-test of the *triple codas* indicates that there is significant difference in the pre-test and post-test as the significance level is less than 0.05. From the result, it can be inferred that Yemeni control group has significant improvement in the achievement of post-test in triple codas.

Table 5 below shows the mean scores of Yemeni experimental pre-test with post-test results.

Table (5): Mean Scores of Yemeni Experimental Pre-test with Post-test Results

Task	Pre-test		Post-test			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*
Triple Onsets	3.21	2.26	6.95	2.04	9.730	0.000
Triple Codas	2.29	1.77	6.05	2.70	8.055	0.000

According the results displayed in the above table, the t-tests of *both tasks* indicate that there is significant difference in the pre-test and post-test results as the significance level is less than 0.05. From the results, it can be inferred that Yemeni experimental group has significant variation in the achievement of pre-test and post-test. Based on the results, it is evident that the achievement of Yemeni experimental group in the post-test is significantly higher than their achievement in the pre-test.

Table 6 below shows the mean scores of native control and Yemeni experimental post-test results.

Table (6): Mean Scores of Native Control and Yemeni Experimental Post-test Results

Task	Native Control		Yemeni Experimental			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*
Triple Onsets	5.80	1.64	6.95	2.04	1.182	0.300
Triple Codas	2.80	2.59	6.05	2.70	2.482	0.018

From the above table, the result of the t-test of *triple onsets* shows that the mean marks of native control group and Yemeni experimental group's post-test are statistically same as the significance level of the t-test is greater than 0.05. The result indicates that there is no

significant difference in the achievement of native control group and Yemeni experimental group's post-test. However, the result of the t-test of *triple codas* shows that the mean marks of native control group and Yemeni experimental group's post-test are statistically different as the significance level of the t-test is smaller than 0.05. From the results, it is evident that the achievement of Yemeni experimental group in the post-test is significantly higher than the achievement of native control group.

Table 7 displays the mean scores of Yemeni control and experimental post-test results.

Table (7): Mean Scores of Yemeni control and Yemeni experimental Post-test Results

Task	Yemeni control		Yemeni experimental			
	Mean	Std. Deviation	Mean	Std. Deviation	*t-test*	*Sig.*
Triple Onsets	3.47	2.92	6.95	2.04	6.012	0.000
Triple Codas	3.03	2.43	6.05	2.70	5.132	0.000

On verification of the table above, the results of the t-test indicate that the mean marks of Yemeni control and Yemeni experimental groups in *both tasks* are statistically different as the significance level of the t-test is less than 0.05. The results show that as far as the post-test of the two tasks is concerned there is significant difference in the achievement of Yemeni control and Yemeni experimental groups. From the results, it is evident that the achievement of Yemeni experimental group in the *both tasks* of post-test is significantly higher than that of Yemeni control group.

6. General discussion

6.1 Pre-test

According to the results presented in Tables 1-3 of native control group (i.e. English native speakers) regarding their sensitivity to the triple onset and triple coda constraints of the consonant sounds, it is found out that their mean achievement scores in the *Two Tasks* were 5.80 and 2.80, respectively. As for the Yemeni experimental group, their mean achievement scores in the pre-test were 3.21 and 2.29, respectively, and the mean achievement scores of Yemeni control group were 3.42 and 1.82, respectively. Therefore, the mean scores for native control group are higher than that of the Yemeni groups in the *triple onsets*. However, the mean score for native control group is statistically same as that of Yemeni experimental and Yemeni control group in the *triple codas*. These results help us confirm Hypothesis 1 that, "*The achievement score of native control group on triple onset clusters is significantly higher than that of Yemeni experimental and Yemeni control groups in the pre-test*", and disconfirm Hypothesis 2 that, "*The achievement score of native control group on triple coda clusters is significantly higher than that of Yemeni experimental and Yemeni control groups in the pre-test*".

Given the fact that the phonotactic constraints of English are not taught explicitly at Thamar University and also the participants' mother language, Arabic, that does not admit any double or triple onset clusters in the onset position, it was predicted that Yemeni EFL learners will be less sensitive, compared to the English native speakers, to the task which focused on the triple onset consonants. The results obtained from Yemeni EFL groups are in congruence with previous findings. (Weber and Cutler, 2005: 597) conducted a study on German learners of EFL and native speakers of American English. Their findings show that proficient L2 learners can be successful in mastering the segmentation of continuous speech,

but they may not be able to prevent interference from their native language constraints in their L2. Bin-Hady's (2016: 141) finding which reveals that Arab learners of EFL fail to master the triple clusters of English in which they tend to insert the front short vowel /ɪ/ in syllable-initial and final of English words. For instance, learners produce */sɪblɪ:n/ for 'spleen', */sɪtreɪn/ for 'strain', */sɪkræp/ for 'scrap', etc. by breaking the clusters and inserting the vowel sound /ɪ/ after the first consonant in the onset position. Similarly, Na'ama (2011: 145- 65) conducted a study on 45 Yemeni undergraduate EFL students at Al-Hodeidah University (levels 1-3). He analysed the errors Yemeni students make in the English consonant clusters' system, especially in pronunciation. Like Bin-Hady (2016), Na'ama claims that Yemeni EFL learners have the tendency to follow the strategy of inserting a vowel within an existing string of clusters. They pronounce the English words that have two clusters or more, either word-initially or finally as *(/spɪred/, /spɪlended/, /pɪleɪ/, /nekɪst/, etc.) for 'spread', 'splendid', 'play', and 'next', respectively.

From the results, it can be inferred that even the native speakers of English could not do well in the triple codas. This is due to the fact that constraints on codas are more complex when compared to onsets. In this study, natives could produce the triple codas properly, but they failed to recall words, or provide examples, that end with triple codas.

Based on the results obtained from the present study and the findings from previous studies, the researcher relates the fail of EFL learners to master, either in terms of producing or learning about them, the triple onset and coda clusters into two reasons. *First*, the lack of an appropriate, comprehensive and explicit teaching for the clusters of the target language may result in being insensitive to the cluster constraints of that language. Secondly, the system of clusters of the mother tongue that does not permit such consonant clusters in the onset positions, as is the case of Arabic, may lead learners to transfer their L1 rules of clusters to L2. Hence, it is suggested that conducting an explicit and comprehensive teaching

for the clusters and raising the awareness that L1 cluster rules may differ than that of L2 may help learners avoid such fail or insensitivity towards learning about or producing the constraints in general and the constraints of triple onsets and codas in particular of any new learned language.

6.2 Post-test

Yemeni Control Group: The Post-test results of *triple onsets* reveal that Yemeni control group's sensitivity to English consonant phonemes *did not change* when compared to their results of the pre-test. According to Table 4, the t-test shows that their mean score in the post-test remained statistically *same* as that of their pre-test. In fact, these results of post-test were expected as Yemeni control group showed no sensitivity to the triple onsets of English consonant phonemes in the pre-test and scored less than native control group (see Table 3).

As for the post-test results of *triple codas*, it is reveal that Yemeni control group's sensitivity to the triple codas of English consonant phonemes *changed*. Recall that this group did not do well in the pre-test and showed poor knowledge on the topic. However, the t-test indicates that their achievement in the post-test improved (see Table 4). The improvement could be the result of the implicit teaching of clusters when taught the course of Phonology for one whole semester by the researcher.

Yemeni Experimental Group: The post-test results of Yemeni experimental group reveal that their sensitivity to the *triple onsets and codas* of English consonant clusters *changed*. Based on the results shown in Table 5, the t-test indicates that their mean scores in the post-test in the *two tasks* are significantly higher from their pre-test scores. Similarly, their achievement in the *triple onsets* in the post-test significantly improved and equalized with that of the native control group (see Table 6). However, Yemeni experimental group's achievement on the *triple codas* in the post-test significantly improved and scored higher than

that of native control group. Therefore, Yemeni experimental group showed sensitivity to triple codas of English consonant phonemes after the intervention.

According to Table 7, it is evident that the achievement of Yemeni experimental group is significantly higher than that of Yemeni control group. Therefore, these results allow us to disconfirm hypotheses 3 and 4 that state: "*There is no significant difference in the achievement of experimental group of Yemeni EFL undergraduate learners taught triple onset and triple coda clusters of English consonant phonemes over the control group*", and accept the alternative hypothesis that: "*There is significant difference in the achievement of experimental group of Yemeni EFL undergraduate learners taught triple onset and triple coda clusters of English consonant phonemes over the control group*". These results indicate that the sensitivity of Yemeni experimental group to *triple onset and triple coda clusters* of English has developed by the explicit and comprehensive training they received.

7. Conclusion, Pedagogical Implications and Recommendations

The present study was carried out to examine the impact of the explicit teaching of English phonotactic constraints on the achievement of Yemeni EFL undergraduates in triple onset and triple coda clusters. The collected data were analysed statistically by utilising Excel for Windows and SPSS package. The main statistical tools employed in the analysis of data were mean, standard deviation and two-independent t-test.

The pre-test results revealed that Yemeni EFL groups were less sensitive to the triple onset clusters of English and their achievement was less than that of the English native speaker group. This research relates the fail of Yemeni EFL learners in mastering the clusters into two main reasons. First, the mother tongue of the participants, Arabic including their dialect, that does not admit consonant clusters in the onset positions and hence Yemeni learners may transfer their L1 rules of clusters to the target language, English. The second

reason could be related to the lack of an appropriate, comprehensive and explicit teaching for the clusters of the target language which in turn results in being insensitive to the cluster constraints of that language. As for the achievement of Yemen learners in the triple codas, the findings showed that Yemenis were similar in their achievement to those in the native speaker group. In fact, the results of the triple codas revealed that both native and non-native groups did not have good knowledge about the clusters permitted in the final position and this supports the argument that codas are more complex than onsets and they do not lend themselves to rather simple formulas as it happens to onsets.

The post-test results of Yemeni control group revealed that the Yemeni control group did not attain significant improvement in the triple onsets of English when compared to their pre-test results. However, a good improvement has been noticed in their achievement in triple codas and that could be due to the effect of the implicit teaching of the Phonology course they received during the period of data collection. As for Yemeni experimental group, the results revealed that their achievement on the *triple onsets* significantly improved and equalized with that of native control group. In addition, their achievement on the *triple codas* improved and scored higher than that of native control group and this improvement could be due to the effect of the training programme conducted on this group. Therefore, it is suggested that teaching phonotactic constraints explicitly and comprehensively can help EFL learners be sensitive to the clusters in general and to the triple onset and coda clusters in particular of the target language. The above suggestion is inferred as the results of the current study reveal that with appropriate training, EFL learners can improve and make the learning of certain English-specific phonotactic constraints better and faster. Future research might consider the effects of training of the phonotactic constraints in the syllabification, stress and pronunciation. In addition, carrying out a related study based on an acoustic analysis would

be of great advantage to measure the production of triple clusters by the Arab learners of English.

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Appendix A:

Task 1: Put (√) for the English *triple onset consonant clusters* found in the initial position.

1.	spr	( )	2.	spl	( )	3.	spj	( )	4.	spw	( )
5.	str	( )	6.	stl	( )	7.	stj	( )	8.	stw	( )
9.	skr	( )	10.	skl	( )	11.	skj	( )	12.	skw	( )
13.	lkw	( )	14.	pkj	( )	15.	ʃkw	( )	16.	dpr	( )
17.	fbw	( )	18.	tbl	( )	19.	dtr	( )	20.	mtj	( )

Task 2: Put (√) for the English *triple coda consonant clusters* found in the final position.

1.	dst	( )	2.	kst	( )	3.	mpt	( )	4.	ŋkt	( )
5.	nst	( )	6.	ŋst	( )	7.	lpt	( )	8.	lst	( )
9.	rkt	( )	10.	rpt	( )	11.	rps	( )	12.	rst	( )
13.	rlk	( )	14.	rmp	( )	15.	rsk	( )	16.	lmp	( )
17.	nsk	( )	18.	str	( )	19.	spr	( )	20.	skr	( )

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